Woodstock

Tutorial Answers

Answers to the tutorial exercises provided in Chapter 7 of the Woodstock Modeling Reference.

Tutorial One:

Exercise 1:

The 100,000 m3 volume target is feasible (i.e., the target was met in every planning period of the planning horizon).

The initial estimate of allowable cut made by changing the volume target in 20,000 m^3 increments is **140,000 m^3** /period. Using a binary search, the estimated allowable cut was **157,734 m^3**/period.

Exercise 2:

The text below shows the modifications to the MODEL1 GRAPHICS section necessary to produce the screen shown on page 76 of the Woodstock Modeling Reference.

```
GRAPHICS
*WINDOW "Harvest levels (000's of m3)"
*WINDOW "Area harvested (ha)"
*WINDOW "Inventory (millions of m3)"
*WINDOW "Age class distribution"  ;add graph window for ageclass report
*LINES
tot_pulp 1 1000  ;scale numbers by 1,000
areacut  2
growing  3 1E6  ;scale numbers by 1 million
_AGECLASS 4 ;generate an age class distribution and place in the 4th graphics window
```

Tutorial Two:

Exercise 3:

Using a harvest target of 160,000 m^3, the success rate was **0%** after 50 iterations. See Chapter 9, page 62 of the User's Guide for a discussion of random transitions in Woodstock.

The highest harvest target that may be set before the success rate falls below 100% is **154,000 m3**. Chapter 4, page 29 of the Modeling Reference and Chapter 15, page 116 of the User's Guide have detailed discussions of Monte Carlo simulation and conducting a Monte Carlo simulation analysis.

Tutorial Three:

Exercise 4:

The table below shows the number of iterations required to converge to solution using either an absolute (1,000 m^3) or a percent (1%) tolerance. In all cases, a 1% tolerance yielded a lower harvest level than a 1,000 m^3 tolerance (4,718,750 m^3/period versus 4,732,910 m^3/period respectively).

	Cutvol = 3.0E6	**Cutvol = 4.0E6**	**Cutvol = 4.5E6**	**Cutvol = 5.0E6**
Tolerance 1,000	Iterations = 14	Iterations = 14	Iterations = 15	Iterations = 16
Tolerance 1%	Iterations = 9	Iterations = 9	Iterations = 9	Iterations = 10

Fewer iterations are required to converge to solution using a 1% tolerance. The reason is obvious: a 1% change in the volume target (40,000 m^3) is greater than an absolute tolerance of 1,000 m^3. Woodstock stops iterating once the change in the harvest has exceeded the tolerance, therefore higher tolerances result in faster convergence. For the same reason, higher tolerances yield lower target levels; smaller tolerances force Woodstock to perform more iterations and continue to increase or decrease the target level beyond the level determined using higher tolerances. The starting value in the *TARGET statement had virtually no impact on the number of iterations. For a further discussion of conducting a binary search analysis, see Chapter 15, page 116 of the User's Guide and Chapter 3, page 26 of the Modeling Reference.

Exercise 5:

The following table summarizes the ACE resulting from increased silviculture (planting and thinning) in the first planning period. Increased thinning alone did not generate an ACE, so the ACE produced by increasing thinning and planting together was the same as that from increasing planting alone.

	Periodic Harvest Level (m3)	ACE (m3)
No increase	4,523,437	
Increase plant only	4,570,312	46,875
Increase thin only	4,523,437	0
Increase plant *and* thin	4,570,312	46,875

The ACE shown in the table below resulted from increases of 1,000 hectares in each of the first 15 planning periods. Note: you will have to add additional target statements to the QUEUE section for each of the first 15 planning periods. As expected, the ACE was greater than before, but the trend was identical. Chapter 11 of the User's Guide discusses the QUEUE section and defining target levels.

	Periodic Harvest Level (m3)	ACE (m3)
No increase	4,523,437	
Increase plant only	4,710,937	187,500
Increase thin only	4,523,437	0
Increase plant *and* thin	4,710,937	187,500

Tutorial Four:

Exercise 6:

Since an action is used to trigger natural regeneration, Woodstock needs a target and action source statement in the harvest queue. Otherwise, Woodstock will not schedule the action. Sure enough, removal of the target statement for `rgnarea` caused the area naturally regenerated to drop to zero hectares in all periods. The harvest level also fell from 1,926,773 m^3/period to 1,409,484 m^3/period.

Differences in the final harvest level for CASE1 and CASE2 are attributable to differences in site selection for planting. In CASE1, the planting decision occurred at the time of the clear-cut; the model chose either to clear-cut and plant or to clear-cut and naturally regenerate a site. In CASE2, the planting decision occurred *after* the decision to clear-cut (i.e., each action had its own selection rule). In this case, the model planted the best growing sites first, which permitted an increase in the harvest level.

You can modify CASE2 to achieve the same answer as CASE1 by making the selection rules for planting the same as those for clear-cut (i.e., _MAXDELTA soft 1; _MAXDELTA soft 2).

Tutorial Five:

Exercise 7:

It does not matter in what order planting and thinning occur in the harvest queue. We tried several different combinations of planting and thinning, all to no avail. The harvest level remained the same in spite of the ordering.

Gstock is an inventory output (defined using _INVENT) and therefore does not require that an action occur for it to be calculated. Woodstock, therefore, does not require an action source statement for the Gstock target statement (or for any other inventory target statement for that matter).

Relaxing the ending inventory restriction from 60 to 50 percent of the initial growing stock level increased the harvest level by slightly more than 2 percent (1,637,847 m^3/period versus 1,673,889 m^3/period respectively). This indicated that the ending inventory target was not overly restricting, but by relaxing it, Woodstock would be able to increase the harvest level.

Tutorial Six:

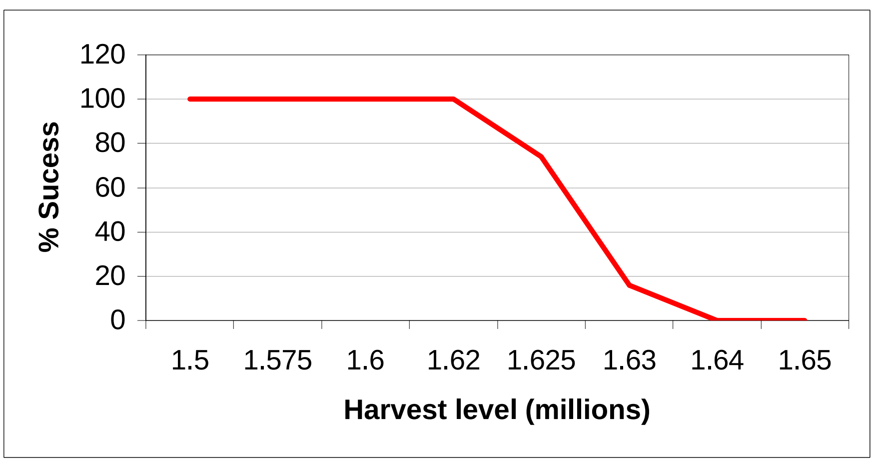
Exercise 8:

For the CASE4 model to yield the same harvest level as CASE 3, you would have to increase silvicultural spending by 1.2 million dollars. You cannot increase the harvest level by modifying the allocation of dollars spent on planting and thinning in the QUEUE section.

Tutorial Seven:

Exercise 9:

The appropriate harvest level depends on your aversion to risk, as does the amount spent on silviculture to lessen risk. For example, a risk-averse decision-maker may choose a lower harvest level or spend more on silviculture to reduce risk than would a risk-indifferent decision-maker.



Tutorial Eight:

Exercise 10:

The linear programming (LP) solution is better than the binary search simulation because the LP found a combination of treatments (in terms of the development types treated and the timing of treatments) that generated a higher harvest level. To read about some of the advantages and disadvantages of LP, see Chapter 5, page 53 of the Modeling Reference.

Exercise 11:

To minimize the area planted, in the OPTIMIZE section, (1) change the LP objective to one that minimizes the area planted and (2) set as a constraint the harvest level determined in the initial run (1,771,974 m^3/period). What we are doing is asking the model to plant as little as possible in each planning period while maintaining the same harvest level as before. In the worst case, the model will plant exactly the same amount of area as it did before, but you won't know for certain unless you ask.

```
OPTIMIZE
*OBJECTIVE
 _MIN plarea 1.._LENGTH          (1)
*CONSTRAINTS
 spfvol >= 1,771,974     1.._LENGTH        (2)
 budget <= #dollars       1.._LENGTH
 gstock >= #endinv         _LENGTH ;ending inventory constraint
```

In the first run (in which we maximized the harvest level), the total area planted over the planning horizon was 26,499 hectares compared to 23,591 hectares in this run. Concomitant reductions in silvicultural spending amounted to over 2.7 million dollars! For an overview of LP, see Chapter 5 of the Modeling Reference; for instructions on conducting an LP analysis see Chapter 15, page 117 of the User's Guide.

Questions?

We would be happy to answer any questions you may have about Remsoft, Woodstock, or any of our other software packages.

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